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ABSTRACT

This research deals with how Supply chain management (SCM) is done in the production industries, how the Supply chain management had become an inevitable part in the working of the production industries. As everyone will be thinking the Supply chain management is only just the management of the supplies in and out of an industry but it is more than that, it deals more on the other aspects like the integration of all members in a SCM. The supply chain management had evolved a lot in its every aspect from the starting to the current present time like initiation and implementation of new strategies and trends to cope up with the developing growing market with other rivalries in the production industries section. This research study will be focusing more on the well planned and implemented supply chain (SC) can benefit an industry by giving profits in return. During the implementation of the SCM it is certain encountered by the challenges and adequate remedial measures like the supply relation management, Lean supply chain management and Just in Time are adopted. The adoption of new trends like the Just in time, Lean supply chain management are well focused by the undertaking of studies of industries like the Toyota, Honda and Ford. The benefit for JIT is showed by the help of data analytics by the data obtained from the Toyota production from the year they start the JIT strategy. With the result of the data analytics had predicted how the company will be benefited after the implementation of JIT in their SCM. After the data analytics found that the after the implementation of the JIT will surely bear profit. The SCM has known adopted the many new advancements in their working like the adoption technologies like the Block chain technology. The block chain technology had played a well good role is keeping a register for all the data and the process done in the SCM in a most secured way which prevents the unauthorised access from inside and outside. Along with these the study also focused on the impacts of these strategies and the new advancements have on the SCM.

Keywords: Supply chain management, Supply chain, Supplier relationship management, Lean supply chain management, Just in time supply chain etc.

Contents

LIST OF TECHNICAL TERMS AND ABBREVIATIONS

SCM	**Supply chain management**
SC	**Supply chain**
OM	**Operations management**
IC POLICY	**Inventory control policy**
SRM	**Supplier relation management**
AI	**Artificial intelligence**
RPA	**Robotic process automation**
SMB	**Small and medium Business**
ERP	**Enterprise resource planning**
WMS	**Warehouse management system**
LSCM	**Lean supply chain management**
TPS	**Toyota production system**
BCT	**Block chain technology**

TITLE PAGE

Supply chain management in production industries

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CHAPTER 1: INTRODUCTION

As the word supply chain itself simply can be defined as the interpolation between the company and their suppliers to produce the final output and distribution to the final end user (Kenton, 2020). As the supply chain is considered as a main aspect in the industries because it plays a crucial role in the getting the raw products for the industry to process and to give the finished product to the concerned consumer, so it needs to well managed. Here comes the supply chain management in the equation. Supply chain management can be described as the management of the interconnection of companies through upstream and downstream links between the activities that generate value for the final customer in the form of products and services is known as supply chain management (Nigel Slack). As this management process is one which deals with several companies through the production and delivery to the customers, hence it should be sophisticated one and need to be well managed and for that they will develop special strategies and process for the well working of each phase. The SCM works on the implementation of several factors which is needed for the proper carrying out of the whole process (Daneshwar,2020). The main objective of SCM is to get the maximum of the value that they can generate and the value that they generate is also called as the supply chain surplus. this above value is generated as the difference between how much value achieved by selling the product to the customer and the costs that the company had invested in the supply of the product to the customer (Sunil chopra,2013). So, in order to get the profit that the company aims to get hard to achieve if it is not managed and not adapted to the follow of the market, that is for example by eliminating the unwanted expenses and adopting new techniques in the supply chain management. In this scenario Toyota had done exemplary work and it is the introduction of the JIT strategy (Williams and Ludwig,2021). Along with these trends which is already applied there are some new trends which comes in the world of SCM which makes the SCM more efficiently and effectively done in the industries. By this intervention of new trends, the SCM could tackle the challenges in the proper way and could create remedies to clear the challenges they are already facing or to the challenges that coming the future. By proper examination and collecting the theoretical knowledge we will try to achieve the objectives of the dissertation and will try to find the answers to the question that we had framed for the dissertation.

1.1 PRODUCTION INDUSTRIES AND SUPPLY CHAIN MANAGEMENT

Production industries means an industry which works fully by the process which manufactures or produces the products by the conversion of the material into finished products according to the will of the customer or another main companies which use them as sub production companies. In this scenario the supply is having a crucial role to play because the entire working inside the production industries can be accomplished only the proper flow of the raw materials their company and the flow out of the consumers or the main companies which gave them the subcontract. By keeping all this thing, it is clear that for a production industry supply chain management is an inevitable part in their process through out. The proper management of supply chain should be ensured in the above industries. The SCM cannot be carried out very easily because it is complicated process and depends on the several factors and all these factors must be well cared for the supply chain management to yield the projected result which is marked by each industry. Even in this present time some of the well organised and systematically adopted supply chain management of some companies had created a remarkable milestone in the production industries because of the profit that this companies made by effectively adopted supply management. In this category falls some big companies like the Toyota, Honda etc.

1.2 RATIONALE

Supply management the word itself exhibits, that it is chain like structure which comprises of services, materials, information flow that stabilise customers relationship and supplier relationship, order fulfilment which deciphers that supply chain have a big picture in the working of industries other than just dealing in the logistics. Supply chain management deals with all processes like from the basics like planning, implementing and controlling the operation or procedures of the entire supply chain. Above all the mentioned the supply chain management also includes the strategies that are needed and to be performed for improving their supply chain working in an effective way. So, by combining all these we decide a upon how supply chain management had an inevitable part in the working of the production industries. By any compromising in the part of the supply chain management will create a greater damage in the working of the entire industry

1.3 THE OBJECTIVES AND QUESTIONS

As this dissertation will be focusing on some of the objectives and will be trying its best to get the result by achieving the objectives. The objectives of these dissertation work is as follows.

- Understand the definition Supply chain management.
- Identify the factors affecting supply chain management.
- Knowing more about the challenges faced by the supply chain management.
- Finding the new innovative techniques adopted in supply chain management.
- Knowing the supply chain trends that appeared recently.

Along with the objectives also trying to find the answers to some questions which come in process of supply chain management have been adopted on an industry.

Q1. How supply chain management benefit the production industry?

Q2. How to deal with the challenges the supply chain face in running?

Q3. What are advancements supply chain in the modern industry?

And by doing the dissertation in the structured and well organised manner by collecting the best theoretical explanation from the journals and articles and other well published works may be able to find the answers to the questions which are framed for the dissertation.

1.4 RESEARCH GAP

The research gap, the word itself denotes a void space or problem in the dissertation or the research. The research gap in research always remains as a question throughout the work of dissertation and it should be identified very clearly and should be noted in the dissertation section for understanding by others. Thus, the people can be easily note down what are limitations of the research and to what extend the findings can be related to the working conditions of the production industries. As the main objectives of the dissertation revolves around the role of SCM in the production industries. As due to the current Covid-19 pandemic situation the research can be done only by the study secondary data and we

therefore, collect the data from the published works on the internet. So, it always lacks the understanding of the real working of an industries SCM as we don't have a chance to witness and analysis the working of SCM in the industries. Even if we are able to find solutions to the problems that SCM facing now a days, but we can't predict sudden unnatural problems like pandemics or natural disasters which can affect the SCM badly by the disruption caused in the transportation of the logistics movements. So, adopting all the measures properly in the SCM can't guarantee benefits all times. When each problem come, we need to alter the newly introduced or take away to counter with the new difficulties. In the strategies adopted by the SCM the JIT is one of the remarkable one which limits extra cost on production industries and thus making a profit on the production industries. (R.Nicole,2010) Toyota had implemented the JIT and came into action from 1952 onwards. Now, due to the modern challenges and obstacles in the SCM will the JIT strategy will give the company a stability in the market in the coming future. This research gap is addressed in the research with the help of data analytics.

CHAPTER 2: LITERATURE REVIEW

By understanding the word SCM doesn't means grabbing some theoretical ideas and simply adopting it to the industries may provide good profit for the industries at the end of the business. Rather it should keep a keen eye in the proper flow of the raw material into the productions industries for manufacturing and from there to end consumers. Supply chain management can be well said like systematically working cycle which should be having placid and lucid connection between different sections of the industry like services, materials selection and movement, information flow that helps to have a good relationship between the customer or consumer and the suppliers, ensuring the properly the things that should supplied is done in the exact time without any delay.

2.1 THE WORD – OPERATIONS AND SUPPLY CHAIN MANAGEMENT

According to (Krajewski *et al.* 2016) Before dwelling more into the SCM we should be more familiar to the word operations and operations management. Operations are group of resources performing altogether or may be consecutive with other processes for carrying out some main functions. The OM describes as the standardised design, direction, and control of processes that transform inputs into the services and products for not only the internal customers but also for the external customers. When this process come in the phase of supplies it can be linked to each and each other and thus can be called as the supply chain. SCM is the systematic and efficient synchronized pathway between the customer and suppliers to match up with the flow of materials, service, and information a customer's demands. So, we can evidently point out to that the OM and SCM plays a pivotal role and proper coordination and working can be bear a wealth and value for the industries. In these the operations serve as major role in the upper management positions in the production industries because the operation manager who is the head of the operation in the firm all the other heads of the firm's departments like customer service, service, production, inventory control and quality assurance heads will be directly working under the operation manager in the firm. Hence the operation manager will be one of the topmost designated posts of the production industry or the manufacturing industries and are given by the designated post like the vice president of manufacturing to the chief operation manager of the firm.

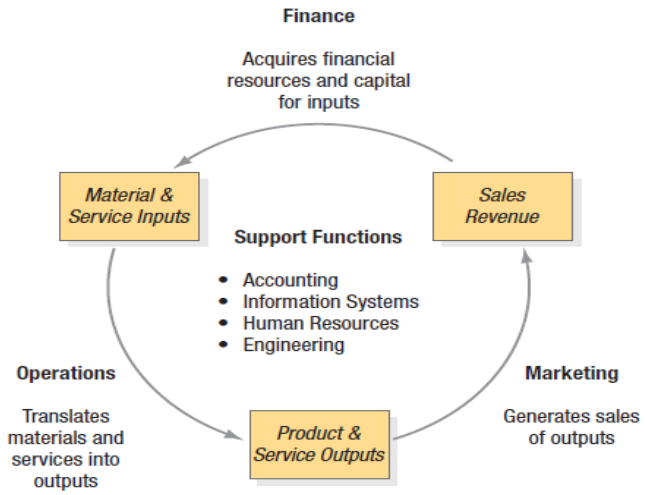

Figure 1: shows the connection between each functional areas of the business. (Source: Krajewski et al. 2016)

In this figure 1 it shows as the key functions in an organisation. and circular path defines the boned relationship between the operations, marketing and the finance. According to the strategies adopted by the organisations the finance and operation sections decided they must invest resources and converting them into the products for the customers. For reaching these outputs to the market and from there to the customer the marketing sector play a crucial role. Therefore, marketing is an unavoidable part of the industry because they will generate the value the money from the market to the stake holders of the industries. So, we can say that we should consider this circle as one body and not individual sections because well-mannered functioning of these sections together will define the effectiveness of the industry from the base level to the top.

2.2 FACTORS AFFECTING SUPPLY CHAIN

(George and pillai,2019) says that the factors affecting the supply chain are SC structure, Inventory control policy, information sharing, Customer demand, Forecasting method, lead time and review period length. It states as

> **SC structure**: This SC structure is further divided into several categories, and it is done on the behavior like to how many organizations have the entire SC chain interlinked in between before the customer gets the final finished product in the hand. As the structure is gaining more and more complexity is becomes the total cost on the inventory also increases as the demand of the product may overcast or simply create great inefficiencies in the basic SC chain.

IC policy: IC just its name resembles that of having a control over the inventory for the move in and moveout of goods from the inventory for the working of the organization process of converting the raw materials into products. The IC policy is framed always to make assure that have right goods in hand for the processes to carry out and to avoid shortage, to provide proper accounting of the goods in the hand. Along with these another main objective is to maintain an economic equilibrium between the costs incurred and the costs saved by keeping the proper stock of goods in the hand. This above two are the main things which should be taken more into the account by the IC policy.

Information sharing: the information sharing can be considered as one of the main factors which affect the SC. The above statement is valid because as SC is having so many companies in between for the proper execution so, a proper information sharing should be maintained between them. Only through the proper channel of sharing information in between the organizations in the SC the SCM can be managed in a well manner. A well-developed information sharing platform only can give a good variety of customized products to the customers at earliest and can understand better and fast the changing tastes of the customers.

Customer demand: customer demand is also one of the main factors of supply chain which cannot be excluded at all. The customer demand is always fluctuating during the course time that may depend on various known or unknown reasons. Therefore, the proper prediction of this shift cannot easily tracked and for that exact purpose of tracking down the change the organization should having good pattern or formulae to track the change at the earliest and if it is not done, the loss that occur by the SC will be very high.

Forecasting method: when the forecasting is done good, means had found on which side the customers fall or which trend they follow in the coming future in getting the services from the organization or products from the organizations can create a great

positive for the SC, because the firms can run the SC according to the changing will of the customers and can have a goodwill form the customer's side.

Lead time: this can be stated as the time gap between the receiving the orders and the final delivery of the goods to the customer's hand. The long lead time also creates issue in the SC because that may also cause the customer demand to change, and the inventory get loaded with extra goods and causes loss on the side of the money that is spend in movement of the particular item.

Review period length: this refers to the time between two successive evaluations of the inventory status to determine whether anything particular is needed to be reorder or to keep in stock due to the demand of product from the customer's side. This enables the firms to find which products is having the best movement in the market and that need to take care in the SCM that should transport very fast to meet the requirement of the customer. At the same time, they also get the idea about the product which performs less in the market, and they slow down the SC process on that particular item and can save the inventory costs on it also.

2.3 THE CHALLENGES FACED BY SUPPLY CHAIN

(McAllister, 2021) states that as the SC is a sophisticated process the management of this process is also very difficult and the on the progress of the managing the SC encounters several challenges also in-between. The challenges are as follows:

Managing customer expectations: As the customer expectation may change rapidly according to the change in the market. For understanding the customer expectation about how they see the market can be only achieved in the SCM by having a proper transparent communication platform constructed between the SC managers and the customers. By the proper utilization of the exact platform that they built for achieving the above, the SC managers can easily enter the request and process it further without again consulting with the customers may cause extra delays in the SC.

Managing the suppliers: along with the management of customers dealing the suppliers in the SCM is also a crucial part to considered along with. This can be very done by the SRM. Finding the convenient and proper supplier for an process to be carried out is very important and proper information and guidance should be passed to them in the process of SC. In the running of the process if any problem had been faced by them, the SC managers should find it an rectify it before it causes some serious issues in the SC. For this to achieved they should have a good relationship between the suppliers and that can be achieved by the SRM.

Maintaining the quality and sustainability: As the SC becomes a globalized matter which means it's been followed and practiced all over the globe in various organizations and firms. So, in the above there may be some chance for the quality of the products which are in SC cycle may be of low quality and by the delivery of that to the customer may affect the goodwill of the firm. So, they always insist the suppliers to stick with the quality standards and the thorough checking of the products. Even though the above is implemented they still face difficulties as the SC is enormously big and complicated.

Access to data: The access to the supply chain data is important, the particular reason for the circumstance is that only by this they can implement the new guidelines and educate about the new alterations that they adopt in the SC. When they lose the access to data right in any part the SC, they whole system get collapse and that also happen when the SC transforms toa big and sophisticated one.

Risk mitigation: The risk mitigation is also key point to keep in mind for the SCM because they should be prepared in any says to encounter any risk that come in the path of there SCM processing and even that doesn't create a much impact on the SC. The risk may include several internal and external factors, and some

are strike of the worker in transportation, natural calamities etc. If the firm is prepared to prevent any risk before they arrive then it's the best way but some of the risk can't be forecasted earlier like the calamities. So, the reaction towards these should be fast and should be carried out in effective manner. The failure in this section can be very dangerous and can ruin the SC once and all.

2.4 THE NEW TECHNIQUES ADOPTED IN THE SUPPLY CHAIN

According to (pettey,2018) there were any new techniques adopted in the field of SCM. There are notable introductions in the new techniques adopted by the SCM to gain advantage.

ARTIFICIAL INTELLIGENCE (AI)

Among the new techniques which were adopted the prominent and the newly developed one was the interference of the AI in the area of the SCM. This can be also done by the taking the help from other AI implementations by the firm to find and make the alterations in the SCM. For examples in the Olay skin adviser is an AI which depends on the machine learning algorithms to analyze the skin care needs that the customers need. From the above AI the firm can be understood which all the materials are needed to make the product according to the need of the customers. So, we can say that the AI introduction in the firm had developed the SCM of the firm to be done more efficiently. The similar approach had been done by the Flavor Print, this was introduced by the McCormick spinoff Vivanda. By this the firm will be having more idea on the preferences of the customers having on the food items and they can be use this as a leverage to extend the SC.

ADVANCED ANALYTICS

This helps the firm to enable to take the fortune of future opportunities and mitigate the threats that they may face in the course of their processes in the future. With the interpolation of both the predictive and prescriptive analytics the company can yield a good impact on their future supply chain plans and working.

INTELLIGENT THINGS

Now a days SC have been using so many intelligent methods in the SC for the better functioning. This includes the usage of the autonomous vehicle and autonomous robots. This implementation of the automation is done in a controlled environment which provide the safety for the employees working along with these machines. The implementation of the automation will help the firms to get more profit on the SCM because they can be substituted to the work which cannot be done by humans and will create a greater impact in the profit than the earlier stage where they didn't use this new implementation of automation. The RPA allows the SC to eliminate the costs and errors and speed up the process.

BLOCK CHAIN TECHNOLOGY

(Gaur and Gaiha ,2020) said that blockchain will hold a prominent place in the SCM. actually, the BCT plays a crucial role in the bitcoin world and crypto currencies, but the studies shows that if the Block chain technology is successfully implemented in the SCM it will benefit the firm by having more fast, efficient and cost-effective delivery of products, enhancing the traceability, improving the coordination between partners and helping for the easy reach to the financing. The blockchain technology in the cryptocurrency field helps them to have access to numerous parties to transact privately and securely with each other without having an intermediary in between. The same also happens with the SCM when the Block chain technology is implemented in the SCM it helps the limited number of

parties involving in the process of SCM against the malicious other parties when they try to improve the performance of the SCM.

2.5 TRENDS THAT APPEARED RECENTLY IN SUPPLY CHAIN

(Bendis,2021) stated that the last year 2020 was considered as the greening in the supply chain as they always try to stick on the adoption of environment friendly practises in each and every step of the supply chain. As the Covid-19 had struck the global logistics very much in an adverse effect and as result the supply chain has also had the adverse effect on it. The

global trade which is done by the supply chain had lowered by 17.7% in May 2020 as compared to May 2019 specially the trade from U.S, Japan and the EU. The global GDP for 2020 was also gone down. As the pandemic had deteriorate the supply chain there are some new trends which are followed in 2020 which also had the full scope in 2021. They are:

Supplier diversification: (Rector,2019) said that this helps the firms to get the supply from various sources or suppliers. By adopting this strategy, they won't be having any shortage of the product or materials as they will be able to get the things from other suppliers if one can't be accounted for the purpose. Another advantage that comes will be the arrival of more innovative ideas form the suppliers which can be adopted in SC to makes it more efficient. The SCM will be also getting a large pool to find the best suppliers to carry out the Supplies for them in a way which ensures correct delivery of service, fair prices, and quality

Automation: (Bendis,2021) This doesn't include only enabling the robots to work which will make the workflow or the process is better as compared when the same is carried out by the humans. This also includes the adoption of new software will be making most of the SMBs go paper less, that is all the data and processed outputs are stored in the software and it will be more precise and accurate and can be accessed easily and protected also. Now a days all the ERP and WMS are falls in the trend of using the software for managing there SCM.

Focus on eCommerce: (Bendis,2021) this platform always provides the customers to have large section of materials and easy and more delivery of the products to theirs doorstep with tracking. The main advantage that the eCommerce will be providing is also for the SCM. This done because they are having a good look over the customers tendency to follow new trends that occur in the market and also takes their suggestions by review system. From this SCM can plan the replenishment of them inventory and can alter the inventory according to the will of customers and can also note which material is having the great movement in the market.

Cloud based technology: (Bendis,2021): the cloud-based technology had become a very good strategy to be adopted in the Covid-19 pandemic situation as the people are more forced to work remotely. The cloud technology allows the data to be shared in the internet and anyone who is having the authorization can access to working with the related process. This cloud technology allows the firms to cut the extra cost that they used to spend on extensive and intensive technology and can save money. This cloud technology always allows the business to stay in touch with the SC while cutting the costs and making business more effect and competitive than ever as they are always having the connection with data at any time for processing.

JUST IN TIME SUPPLY CHAIN (JIT)

(Murray,2020) said that the JIT is a technique adopted in a situation where the operations are carried out simultaneously with other operations. Simply adoption of JIT SC is making the movement of materials to the location when it is needed only, and this implementation of JIT will result in the reduction of needs to store enormous levels of materials in the warehouse. The main aim of the JIT is to optimise the SC to deliver your customer wants when the wants it , thus generates a easily path of transporting the materials in the SC without spending extra money on the storage in the warehouse. For the implementation of JIT is not that much simple it is laborious process which requires the apt correlation of all the parties taking part in the SC. For the JIT to implement in the SC. The SCM should be have a good understanding in what the customer wants and their demands and then should have good relationship with their suppliers to make the JIT work in good way because the fault from their side may also cause the failure of the JIT.

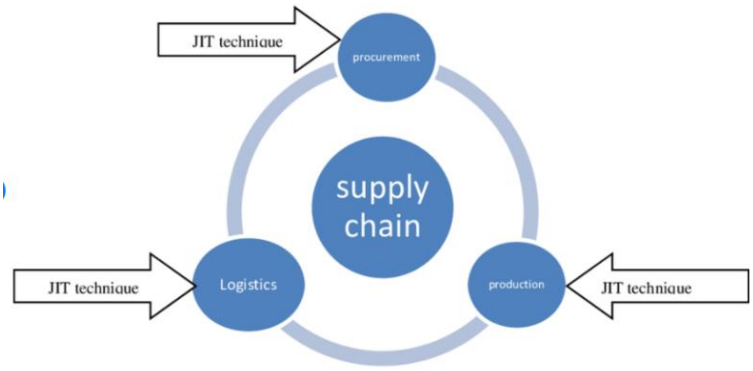

Figure 2: shows the JIT technique be applied in the SC. (Source: Mishra, Kumar and Garg,2013)

LEAN SUPPLY CHAIN MANAGEMENT

(Murray,2019) states the Lean SCM as the lean management is not only applicable to the manufacturing industries but also can be adopted to the firms which would like to organise their business in an systematic manner by avoiding the wastage in any means and non - value added activities. This area where they will have the wastage are the sections dealing with the inventory, time, and costs. To modulate a lean SC in the SCM there should be very keen the areas of Procurement, Lean manufacturing, Warehousing, Transportation.

Figure 3: shows the Lean supply chain management which is applied in a SC. (Source: Murray,2019)

From the above figure it shows evidently in which allows the LSCM should be applied to get the full efficient output by adopting it. If the LSCM is very well taken care in each section surely the plan gets all its result at the end. This is applied in initial step called procurement

where the materials are gathered for processing and taken to the next step manufacturing or processing where a majority of wastages can be cut down, then to the warehousing which eliminate the wastages in the inventory and finally to the stage of transportation where the goods reach the customer or the next firm for further operations. So, if a SCM want to be called LSCM then it should be leaner in all the process it goes in between.

2.6 PROMINANCE OF E-COMMERCE IN AUTOMOBILE INDUSTRIES

The E-commerce had become an integral part of any SC industries had been adopted and are able to yield profits for the industries. The E-commerce had become very popular in this pandemic period and the become one of the top remedial methods adopted by the industries to cop up the challenged that they faced during the pandemic time. (Briefing,2016) states that the E-commerce strategy is less prominent to the automobile production industries. The above happens due to the reasons like the complex nature of the products need to fulfil the end product, SC, SC relationships and etc. The automotive production industries mainly produce the vehicles like cars and the other heavy-duty vehicles, and they will directly showcase and sell in the markets. The working of the production industries is linked with numerous suppliers and dealerships which will provide a number of parts which will be required for the repair or the upgradation of the vehicles this process are very tangled ones and needed a very expert knowledge for the correct assembly as it deals with the ensured proper functioning and the public safety. Thus, the whole production of the automobile industries is carried out by the help of complex SC and dealerships and therefore these industries are controlled by original equipment manufacturers and automakers like the Toyota, Audi and so on. The above like companies won't allow the suppliers to directly come in contact in the market to have an interaction with customers and have their sale there. Instead of that the process is runed by the bug giants like Toyota, Audi etc. they will buy the parts and will assemble the cars according to how the market needs it. The parts required for the production of vehicles are also very complex in nature and they can't be just ordered or checked by the other products which are available in the E-commerce platforms because it ned the thorough study and inspection form the experienced persons or authorities before the further procedures. Thus, due to the complexity in the SC, complex numerous parts needed for the production and SC relationship it can't be shifted to the E-commerce sector very

easily and the shifting wont' goes smooth and they cannot guarantee any profits for the industries by the new shift in the E-commerce.

CHAPTER 3: METHODOLOGY

For every academic works that is done on the basis of a master level need an actual and exact plan before proceeding into the more working. This working mainly depends on which type of data a person is relying upon for the purpose of answering or writing his/her works, how the student will achieve the objective that he set for the dissertation, How the concerned person will structure the entire dissertation work to find the solution of the questions that are framed for the dissertation. The above whole things will be stated in a synoptic way in the methodology chapter or section of the dissertation. The methodology section not only deals with the methods which we use to complete our dissertation, it also gives a brief description about the questions which are stated in the dissertation. The methods which we adopt to find the particular data which will be helpful in finding the answers should be stated in a lucid manner. Also, to make sure how well the collected data could be responsible for answering the questions or how well the data is connected to the dissertation. (15.writers.com) For the collection of data there are two kinds of data which are generally considered in field of dissertation writing. They are:

The primary data.
The secondary data.

Primary data: The primary data is the main type of data which is obtained from the main sources where it comes. Mostly the primary data is collected form the place where the entire working of the firm works and also from where a much more relevant data can be found with any further disparities. Primary data is seen to be the best form of data for dissertations since it can be more depended upon because it allows for deeper scrutiny of the research phenomena. This data comprises of the data which are collected by the interviews with the employees in a firm and conducting the surveys with questionnaire and all.

Secondary data: The secondary data is also the type of data, which is widely used for the dissertation process, but it is having a wide contrast with the primary data. This data collection method is carried out by the collection of data from the already published journal, articles, books, and other concerned relevant published works. The main benefit behind the collection of the data by this method is the more accuracy and perfectionism in the data because this data is already published and therefore, they have the credibility and authenticity in it. And also exclude the human made mistakes in the collection of data in the primary data collection method. As the methodology is considered as a key part of the dissertation because it lays the fundamental basis for structuring the dissertation to meet his goals like achieving the objectives and finding the answers to the questions which are framed in the dissertation. Thus, we can say that the methodology can be considered as the skeleton for the dissertation work or Research. And anyone inspecting the methodology chapter will be clear about the path that adopted for reaching the objectives and the process which are implemented to get the objectives achieved. (Moura,2018) said that methodology is a technique adopted in the dissertation work for structuring the entire work to function good and yield the projected outcomes. This methodology can also be used by some other persons as it narrates how the entire study was done or carried out in a step-by-step manner which can be beneficial for anyone to replicate it for their dissertation or research works. Which means they can also refer to the way which a dissertation should be done to achieve the objectives which are states in it.

3.1 RESEARCH METHODS

In the process of completing the dissertation the main part lies in the methods that are taken for doing the research and these steps should be well specified beforehand. For this to be done there plenty of methods which can be adopted in order to accomplish the task or the objectives which are stated, and the adoption of these methods is entirely dependent on the dissertation aim to achieve, the current conditions in the sectors where we need to collect data, feasibility of data. (skillsyouneed.com,2011) Some common methods which are used in the dissertation are stated as follows:

INTERVIEWS

The interviews are considered as one of the main parts in which the information or data can be collected in a well-suited way and can be structured according to the needs of the research demand. The interview is basically more than a conversation between the interviewer and the concerned person, it carried out by preparing an interview pattern which will travel to the end of the interview by getting all the data the interviewer needs. When the interview comes big scale means with huge group of people it will be very difficult as it consumes more time.

OBSERVATIONS

This method which is called observation is also have wide application in the research sections. This can be very well implemented where the people react to a particular change in the system which they work this can also include the new implementations payment process. The issue with this is that can't be sure about are all the people in organization are observed correctly or if what will be done to the people who are not happy with the new changes.

QUESTIONAIRES

Questionnaires can be good methods when it comes to collect the data from a group of so many people. As earlier discussed about the interview method it won't stand in a scenario where the amount of the data which we need collect is from a huge number of people. A well-prepared questionnaire requires a great amount care and should be organized a well manner can yield a much of the expected outcomes in the collection of data. Even though this method won't be able to get a detailed type of data but can be adopted when we want to get data from a large number of people, so in this case it will be better than the interview method.

DOCUMENTARY ANALYSIS

This method involves the method of collecting the data from existing published documents that is collecting the data in a secondary method from a primary source. This method eliminates the issues that will be facing in the other methods interviews, observation, questionnaires. As the data are taken from the previously published authentic works therefore the genuine factors will be more in the data collected by this method, because of it is widely used in the research fields. The ease of collecting this data by this method is also very high due to easily accessibility of the data in internet and publishing platforms in internet which will provide access.

3.2 RESEARCH APPROACH

For this research to be carried out in an effective manner, the research questions are framed in a manner to provide best outcomes such that the objectives can be obtained effectively by primary data collection. The collection of primary data means collecting the data from the primary sources and not from any other pre published works or academic documents. The primary data collection means by the methods stated above in this chapter methodology like the observations, observations, questionaries, interviews and on. But due to the COVID-19 pandemic there is no way either to conduct an observatory method of the collection data or to make a better survey or questionnaires to collect the data from the employers in a firm because the entire working of each and every production firms had taken the huge hit from the COVID-19 pandemic and all there systems and the working in each industries are unstable and would not be able to get the data form this organisations in this conditions. So, the only way to continue with research is to stick on the usage of the secondary data or documentary analysis. This method had been very common in all research areas as it includes the collection of the data which are published by well-known prominent personalities in each field. The dependency over the data is guaranteed as it is over checked and are published in a platform which gave the recognition for the entire world for accessing as the content in the works are authentic and credible ones. The selection of the exact correct data by the secondary data selection method which can support the path for achieving the objectives are definitely yieldable. By the using the already published works may offer an opportunity to dwell more into the topic to find more concrete concepts which can support the research or

dissertation work in many ways like pointing out the best examples which had happened in the industries and best methods or processes which can be used for examining any working procedures or an improvement procedure which the companies or organisations had adopted to improve their strengths or to limit their weakness.

(Bradford,2021) Unlike the inductive reasoning which mean the going in research topic with no constrained thoughts and try to invent some concepts or some theories. But here the research is taken with help of inductive reasoning. Which means setting up some constraints like questions to answer and will collect the data and theories which are earlier proposed. In this method the research is structured in a systematic way and concluded with all the findings in the research with the answers to the questions framed.

3.3 THE RESEARCH QUESTIONS

How the supply chain management benefit the production industries?

The SCM is always broad concept which should be implemented in an industry which is dealing with the transportation of raw materials and goods and also the supply of services among the company and their subsidiaries. So, in the case of having a properly implemented SCM they will get the benefits like the on time arrival and dispatch of the services and goods to the next section which will need further processing of the received goods till the final end product reach the end customer. So properly installed hierarchical systematic SCM will always bear a good profit and good will for the production industries in the market.

How to deal with the challenges the supply chain face in running?

The main challenges that the SCM are facing are numerous in the number and some among them are very dangerous which is having the ability even to ruin the entire SCM structure. During these problems like the issues that they will face like the meeting the customer expectations, strike among employees, ensuring the quality of

services, managing suppliers, risk mitigation etc. The above each problem will have bad impact on the entire SCM each problem should also have particular remedies to solve like maintain proper communication with workers and the calculating the expectations of the customers, establishing the good SRM in the SCM, the knowing or be aware about what type of risk will be having in the working of the SCM in current and in the coming days and be prepared with remedies to counter each of the risk that they may or may not encounter in the working.

What are the advancements of supply chain in the modern industry?

The world around us is evolving in the course of time and along with that also the technologies and the way to implement it also changes drastically. Even without sticking to the new advancements the SCM also still stay as obsolete and won't be able to pull out what the industries need to achieve by the implementation of a better SCM. This adaptation of the SCM can be evidently noted by the implementation of automation, block chain technology and the special management techniques like the JIT, LSCM etc. The special management techniques like the JIT and LSCM are always projecting towards the profit of the SCM by minimizing or cutting the inventory cost and minimizing the wastage of any services by SCM like the wastage of the raw materials the manufacturing, wastage of the time in transportation etc.

All the above data are collected and analysed by proper research done on the published works on the different companies like Honda, Ford and Toyota. What these companies have done in their SCM to overcomes the challenges that they face the remedies they adopted to overcome these challenges and the new advancements they stick or had implemented to compete in the advancing markets with their other rivalries. Also taking the major company's implementation of the SCM to achieve our objectives which are stated for this research.

CHAPTER 4: RESULT AND DISCUSSION

How the supply chain management benefit the production industries?

4.1 SCM: THE CRUCIAL PART

(Paul,2019) The SCM in manufacturing or the production industry is always one should be very keen in the working and must be considered as the one of the important parts of the entire company's working. There are two important assets the Time and Money, which should be considered in the SCM as the strong pillars which will be able to run the operations in the company in a good manner. Any mistakes done and which will affect these two assets will put the entire company at stake. To avoid these flaws which will affect the time and money the companies must be always equipped with or adopt a proper streamlined SCM. With the help of SCM the company can also be having a good communication between the concerned authorities like the developers, engineers who enable good the outcomes of the product. The sole reasons for the SCM to become a crucial part for the production industries are

The complexity of products than earlier: As the market had grown more rapidly which results in the demands of the customers also to growth with the same pace. As the demands for products had raised and the complete relaying a upon a company and a technology is inadequate to achieve the task within the time frame. So the process should collaborated with ither companies for the process to complete and hence the process of manufacturing will become more complex so a well maintained SCM should be there for the efficient working of the operations which will comprise the collective effort of the all the companies in the chain of working. Thus, a good SCM will enable the good working all the companies in the SC by eliminating the mistakes that may come in the time and money sections.

Production by the sub party companies: In the earlier times a product which is made or developed for a market is processed only by the action of one company but now it had changed a lot. By the more demand on the products in the market the ain company had developed a new method of manufacturing by incorporating a new sub parties like small companies for the production of the products and the main company will be solemnly looking over the overall supervision, marketing. In this scenario there is very chance for getting errors that my affect the entire goodwill of the company as the process is very complex in the

nature. A proper established SCM could be the only solution to maintain a stability in the entire process. Thus, SCM should an integral part of the production companies.

The emergence of new technologies: As the demand in the market increase the production industries need to invent the new technologies for the apt production of these products according to the need of the market. These radical changes can't be accomplished just by one body for that the production company need to have another sub company to use their strategy, technology or even to make them to produce a part of the desired product. In this case the upcoming use or advancements of new technology can only be adopted with a well-equipped SCM.

4.2 IMPACT OF THE SCM ON THE PRODUCTION INDUSTRIES.

(Paul,2019) Save time: A well-structured SCM will be able to save a large amount of time for the production industries. SCM triggers the speed at which the a given company is produce a concerned product and by minimizing the downtime. The downtime minimization is done by the improved input reliability and simplifying the communication ways in which the proper input and the tracking of the products are done by this way they will clear the issue of over staffing or under staffing in the warehouse when there is fluctuation in the order which re coming to the warehouse. Also, will be very prepared for any delay occurred in the shipping to the warehouse. Having a good communication will always let more details to be known to the employers and thus this effective way is very well established by the SCM and by this they will know how much preparation is needed for the coming materials to the warehouse and so will allow arrange the warehouse facilities if there is any unexpected delay occurs. The effect of SCM implementation is:

Cut down cost: the SCM plays a crucial role in the saving time for the industry also this mainly comes in the sections where more money is used to spend like the distribution, production, purchasing sections etc. These are achieved by the proper material handling, equipping good efficient vehicles for the transportation and incorporating new technologies in the transportation and handling like the robot handling the material in the warehouse. In the production section the SCM also ensures proper delivery by the suppliers to the warehouse or to other processing areas to put apart the uneven production losses. In the

purchase sections the SCM plays a good role by eliminating the inventory costs by supplying only the required amount of the goods to the warehouse for the process and in an excess amount which takes more time and money to manage.

Enhance the customer service and customer satisfaction: As in the SCM the process in carried out by numerous sub parties for the proper production of the final product and as they each part is carried out by separate parties so the chance to happen the error will be less and when these sub products are companied for making the main product the quality will be very high and that will make the customers more satisfied with product with good quality. With the SCM the customer will also experience a good impact in the ordering and delivering of the goods as the process in done very fast and there won't be any delay or any uneven happenings.

Strengthens the company's infrastructure: the infrastructure here means the path which is used by the production companies to reach their goals. A good structures SCM will lead the company to a path which helps to plan out their company in a way which benefit them the most. The SCM will help the main production company or the parent company to find the best sub companies who can provide the main company with a very service which helps in the best outcome for the main company in a more economical way.

4.3 SCM IN HONDA AND HOW THEY BENEFIT FROM IT

(Alnaser,2013) states that Honda is one of the leading production industries in the automobile field and they had been very keen in keeping their positions in the market and always working very hard for the customer satisfaction. Honda had split the total SCM process into five elementary sections like Plan, Source, Make, Deliver, Return through the help of these elementary sections they will plan how the entire process should function from the base through the progressive steps, plays how the company should select the best sub dealers for the supply, process for the production making and the final delivery to the customers. The SCM of Honda integrates all the department from its planning to the final dispatch or delivery teams and by this method they will be able divide the tasks to each of them and will be having less chance of mistakes or delays in the process. Role of different employees and their higher authorities in this manner helps the Honda to achieve a better workflow and

enhanced productivity in the working. This kind of managing the SC by all the workers irrespective of their designation helps the Honda to survive in the global market and to compete with competitors in an effective way. The whole process of the SCM in Honda through some process like they stick to a buyer policy by taking the materials from the most trustworthy dealers for the production there by ensuring the quality of the products to be high with much favourable prices which doesn't make the final products too expensive. With this the production of the products at its high quality doesn't help to catch the market. Along with the SCM also keeps a keen interest in the development of new technologies in the market to make their processes easier. With this structures SCM which includes the collaboration all employees from the base to high always makes the SCM firmer to make decision and for the implementation of the new decisions and through the proper communication al the employees will get clear cut idea of what should altered in order to get the projected aim by the company. The SCM also lays strong link between the Honda and the dealers and thereby get to know if supply is delayed or not and can also set the inventory according to the coming supply.

As Honda managing the inventory is also done by the SCM with a strategy called JIT which will only provide the materials in the apt time where it is required thus, they had tried to cut down the extra expense in the storage of goods in the inventory for long time and there won't be any surplus of goods in the inventory as this strategy is applied. They had also kept observing the inventory thoroughly along with the implemented mechanisms to ensure that all the needs of the customers are meet in time without delay and thus they always had the goodwill from the customers, and they stick to the company for their service. By incorporating new advanced software's in the warehouses and its facilities always control the in and out of the materials in the warehouse along with it they are also regulate the cash flow and will be much easier to find where the cash loss happens and will be much beneficial for the company on the financial side. As with SCM they try to collaborate all the employees and dealers under one roof for making any changes and for implementation of any new alterations. So, in this case it will eliminate the barriers in language as the company is diversified because all the concerned employees will get the details in the exact from and will

be able do according to what the company need. Thus, SCM plays a crucial role in meeting the demands of the customers and cutting the wastage in money and time for the company and benefits a lot.

4.4 CHALLENGES OF SCM

How to deal with the challenges the supply chain face in running?

(Ab Rahman et al,2008) states that the main challenges that the SC is facing now is the lack of integration in SCM. Which mean the lack of cooperation between the parties of SCM like the suppliers who provide them with the materials for production process. If the integration of the suppliers in the SCM is failure that happens particularly in the section of management. It is also stated that the main barriers which inhibits or retards the implementation of SCM in the manufacturing industries is the lack of partnership or the collaboration of the suppliers, limited expertise, management commitment. (Bala,2014) said that the supplier plays an important role in SCM because they help the firms to improve their supply cost, responsiveness, reliability, and its competitiveness in the market with other firms. The main decision-making authority won't be showing a great interest in the running a good supply chain integration with suppliers, but they will be more focused on the gaining profit percent by any means. As the customers are continuously coming with new needs in the more complicated the SC becomes and may occur distortion in the process of production and eventually fails to meet the demands of the customers. (Daniel and Pratt,2020) the above problem can be encountered by the usage of a better SRM in SCM.

4.5 ROLE OF SRM

(Daniel and Pratt,2020) SRM is a very well-structured way of approaching to the suppliers who provide the raw materials to the firm and determining the role of each and every supplier in the contribution towards the supply to the firm and helps in the improvement of their process which leads to the success of the overall SCM. SRM lays a platform for the managers to build a relationship with the suppliers based on the importance of the particular supplier in the SCM. (Al-Abdallah et al,2014) SRM is very crucial for the manufacturing or production industries as the firms are dealing with numerous amounts of suppliers in their SCM. The

manufacturing firm should always have best SRM in their SCM as it ensures the exact supply of reliable and frequent deliveries in today's changing and competitive time of industrialization. The SRM can be measured by the means of five main practices.

Supplier quality improvement: the inspections of the incoming raw materials to the firm can be eliminated and it can be managed by certifying the suppliers on quality and giving them the technical support in the fields where they lack them. This will improve the supplier's standards and will result in the overall quality and productivity, enhance the design of the parts that the firms need and will cut down the costs of extra inspection of materials.

Trust based relationship with suppliers: (MacDuff and Helper,1997) This relationship is by a three level of phases.

Competence trust: a belief that the buying company will be able to perform the assured performance that they promise by taking the supplies from the suppliers.

Contractual trust: trust that is laid by the suppliers on the buying firm which is that they continue the contracts with them for further time.

Goodwill trust: belief that the suppliers having on the buying firm that they will always avoid taking unfair advantages and will perform on a basis which benefit both (MacDuff and Helper,1997).

This will improve the cooperation, enhance satisfaction, reduce conflicts and will lead to long term relationships.

Supplier lead time reduction: (Al-Abdallah et al,2014) the lead time in a SC is an unacceptable thing as it lags the SC very much and they didn't get the materials delivered in the spot where it is needed to perform the process as a result the whole process delay. The reduction of lead time will always create a responsible SC and avoid uncertainty and also will reduce problem in shifting the inventories. The above all can be achieved only by a good relationship between the supplier and firm.

Supplier collaboration in new product development: (Al-Abdallah et al,2014) The firms will collaborate the suppliers along with their new technical advanced technologies when they implement in their firms. The collaboration of the suppliers will make the suppliers know more about the objectives and aims of the firm and they will prepare for advanced technologies that the firm will adopt in the coming time.

Supplier partnership: (Al-Abdallah et al,2014) the partnership of the suppliers will help the suppliers to improve the technology, quality, delivery and cost. They will also get to learn more about the decision-making things in the buying firms because as they partnership between the firms are better and will acquire the sufficient requirements for implementing the functions.

4.6 INVENTORY CHALLENGES IN SCM

(Singh and Verma, 2018) states that inventory is a very important aspect to be considered in the SCM because every company must concentrate on and differentiate themselves with their rivalry companies. With the growing demand for various varieties of products in the current growing market the expectations of the customer also increase. If the company wants to sustain in the growing world the companies should give a keen attention towards their SCM to reduce the extra cost, which they encounter in the SC. But for this they have to ensure the running of SCM in an economical way for the company. The inventory management have problems like transportation costs, holding costs, ordering costs and maintenance costs.

(Stanton,2018) possession of the products in the inventory for so long time always increases the costs of the inventory management. For example, with the inventory space is having a huge rent the company is losing a great amount of money in keeping the products for long periods. Keeping the materials in surplus amounts or unneeded raw materials in an inventory space always makes the company to invest more money from there hand into the SCM for maintaining the inventory safely. So, the inventory costs are a major issue in the SCM.

4.7 LEAN SUPPLY CHAIN MANAGEMENT (LSCM)

(Garcia-Buendia et al, 2021) lean is a management system which had been evolved from its original purpose as a set of tools used in production area for making the production more efficient. Lean management focuses primarily on prevention of the waste and fluctuations in the factory plant. The implementation of the lean system along with the implementation SC helps to optimise all activities and information, materials, and financial flows in the production organisation to meet the customer demands is termed as Lean supply chain management. LSCM provides the company with a chance of elimination of wastage, improvement of quality, cost reductions and increased flexibility throughout the SC. Lean management holds a crucial role in the manufacturing or the production industries by providing a path from customer to the sources of raw material. The growth of the production industries outside a single production factory to collaborate upstream and downstream SC partners which demand the interlink of between the SCM partners and LM. Hence LM can be very efficient in the production industries because it will enable the elimination of the wastage in all sectors and also ensures the improvement of the quality. (Ugochukwu et al., 2012) states that because of the increasing global business competition in the world, the production companies are trying to invent many ways to gain advantage in the field of competition from their rivalries. Lean management is an evolving concept in the production industries in this time and is specially implemented in the SC sections. LSCM come into play when the production companies thinks that it was enough to improve the performance from within the organisation. Instead, the improvement must be done across the whole SC. The Lean management implementation in the SC of many companies improved the efficiency of the respective SCs. Hence LSCM is widely adopted by the production companies who seeks to integrate their SC members along with their activities or operations. The LSCM will reduce the wastage and enhance the quality from the process of selection of raw materials to the process when the whole product reaches the customer. The tools used by LSCM are JIT, set uptime reduction, Kanban/ pull system, production levelling, standardised work, total productive maintenance, value stream mapping etc.

(Ugochukwu et al., 2012) The benefits obtained through the implementation of LSCM incorporation are the better value chain analysis, waste elimination, focus of customer end, problem solving and strong and effective relationship, Improved delivery means the delivery of product according to the customer specification in quality and the quantity they wish to have at correct time is possible by effective application of LSCM. The inventory cost holding is avoided by the pull technique of LSCM by taking the product in to the process only when it is required the storage cost is avoided. Identification of value adding activities and waste elimination helps in the achievement of customer satisfaction. The value chain analysis helps the company to understand at what exact position within the operation lies chance of improvements. The continuous problem solving helps to improve the operational efficiency and the quality of the products or services. (Martínez-Jurado and Moyano-Fuentes, 2014) states that the LSCM have a much interlinkage with the environmental sustainability by promoting the green supply chain management also. As the LSCM focused more on the implementation of lean principles on reducing the wastages, making better the quality and delivery times. The green sustainable management focuses more on the implementation of principles which will make the environment more sustainable like elimination of all types of hazards for the environment. Here it is found that the LSCM and green supply chain management is related as the LSCM is also keener in eliminating the wastages which includes the wastages which are hazardous for the environment. The adoption of LSCM tools like lean supplier development, value stream mapping helped the companies to implement the policies which will trigger the green supply management in the SCM which results the environment to become sustainable. The collaborative design and decision making in the LSCM will also aids in the enforcing environment managemental practices at the first stages of the processes. Thus, LSCM can be very useful in adopting the environmentally sustainable principles in the SCM and the working of the companies. (Wee and Wu,2009) states that Ford Lio Ho motor in Taiwan an affiliate of Global Ford motor company had implemented the LSCM to attain good stature in the competitor world, improve quality and human resource management. Through LSCM the company had worked to convert their current state map of working to future state map with the implementation of step of step process. The step includes:

- **Problem Finding**: Here they will find all the wastages in the inventory, production, efficiency drawback sections for rectification purpose.
- **Idea Finding**: For the eradication of flaws like the wastages of time and inventory they implement LSCM tool like the pull system and JIT, promotion of error proofing and critical devices and critical process control to promote the quality. The implementation of total production management to prevent the machine breakdowns.
- **Obstacle Finding**: For the preparation of future state map for the company the new ideas are laid but there is hindrance to these ideas are known as the obstacles.

  Therefore, strict analysis is carried out to find these obstacles and are eliminated before they ruin the ideas implementation.
- **Solution Finding**: After the clear identification of the obstacles and tasks. the company formulate the solution for achieving the future state map. These includes the adoptions of action plans with the help of rebalancing works to reduce surplus manpower wastage. JIT for reduction of inventory wastage, setting up proofing devices and visual aids for making quality better.

After the LSCM implementation, the company get better future state map which cuts the wastages and improves product quality by which total improvement of the company happens and becomes more profitable (Wee and Wu,2009).

4.8 JUST IN TIME (JIT)

(Del Vecchi,2019) states that as the industrial world transformation happens so drastically that also makes new challenges and especially issues in the SCM inventory section. So they require high amount solutions which can be used for cutting down the extra costs in the inventory management in the SCM and therefore they will be able the profitability of the company. In this stage the implementation of the JIT trends come into play. The JIT was introduced by the Japan production industries in the 1950s during the second world war time when the face serious drawbacks in the SC. JIT is a crucial trend which can be adopted in the SCM for reducing the expense on the inventory while increasing the efficiency and profits. JIT enables the company to acquire a clean clear-cut channel to meet the customer demand while keeping the inventory cost in a low state and also by the implementation of JIT a

material or an article is sent to a place only when it is needed and on time. By the implementation of JIT there won't be any wastage of materials or any surplus stock of materials in the company. Before the adoption of JIT, the company should understand how JIT works and process the changes and resources needed to support the company's growth, which includes setting the workers also in a way to support the JIT working. (Mishra, Kumar and Garg,2013) states that in today's world of the production industries more than the product the SC leads the company to success in the market. The JIT plays a crucial role in SCM in lowering the inventories cost. The concept of JIT was widely used and benefits the production industries. The founder of the JIT states Taiichi Ohno that cost reduction is the main goal of the JIT. In JIT all goods are assigned to arrive at the exactly at the time when it is needed without any delay, which can be best explained as produce and deliver finished goods just in time to be sold. No materials or products are meant to be manufactured or delivered until there is demand for them are occurred. JIT can be applied in three sections of the production industries like purchasing, production and logistics.

Purchasing: JIT constructs a connective link between buyer's and supplier's operation chains made of specific management of acquisition which gives an advanced practice of vendor-vendee interaction in the operations. As a result, which will reduce administrative costs for both customer and the supplier at maximum level.

Production: In the production section it was first implemented by the Toyota and returns the company with a tremendous success. The production system is based on firm long-term relationship with the suppliers and capture the raw materials in a lot and transforms them into finished goods based on the requirement of the distributors or the customers. The lot size of production is evaluated using the retailer's sales volume, inventory holding cost, set up cost and transportation cost. The overall cost of production with JIT is lowered by minimizing the inventory cost and improvement.

Logistics: JIT role in the logistics was initially only used in the internal logistics matters but now a days due to the hike in the distribution of production industries the focus of JIT also supervises external logistics like the internal logistics. Here the JIT uses to activities

warehousing and distribution of goods immediately on the demand in the logistics section. Warehousing is located at suitable place for storage to give out the final product or the semi-finished product a stay before it goes to the customers. The quicker to the response of the customers gives more success for the company.

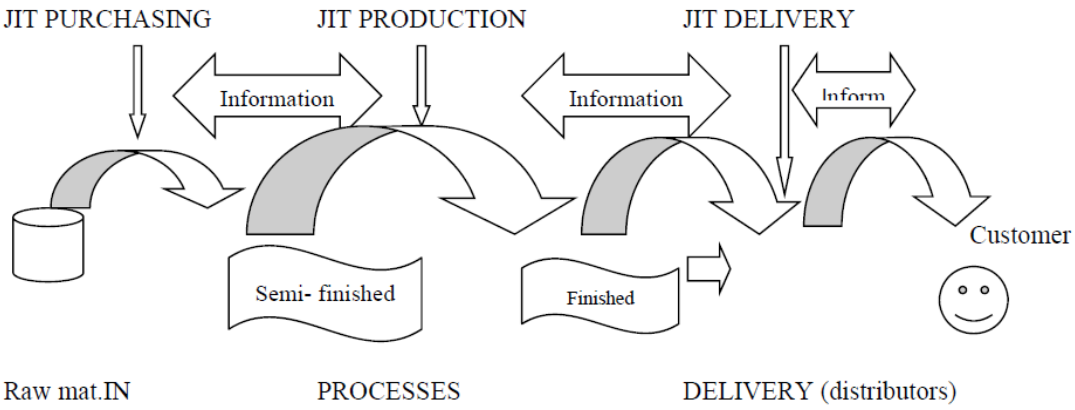

Figure 4: flow of material and information in SC (Mishra, Kumar and Garg,2013).

(Del Vecchi,2019) The objectives of the JIT are

- In SCM it is meant to construct a channel with high reliability and evident performance in the performance indicators which are important for the SCM of the company.
- To alter the production system and the inventory strategy that directs to the maximizing of the efficiency and accuracy to decrease waste and eradicate the requirement of the excess inventory, expenses, and warehouse space.
- Perform optimization with the help of real time analysis and continuous improvement to aim problem occurring areas and maximize performance and reliability.

Benefits of the JIT are

- Lower the inventory costs as there won't be any need of payment for the excess inventory as there won't be any excess inventory after the adoption of the JIT.
- Little raw material expenditure as the company will only start the production once they receive the confirmation of the order from the customers.
- Further saving of the money as there won't be any need to transport the excess amount of inventory which is already in stock.

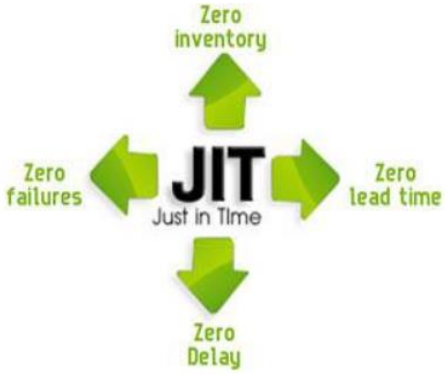

Figure 5: Just in Time Management (Shrimpton,2018)

4.9 TOYOTA'S TRENDS APPLIED IN PRODUCTION AND SCM

(Toyota annual report,2019) TPS in Toyota was adopted by the effort of many years of continuous improvements and trails. The objective of the TPS was the production of vehicles ordered by the customers in the quickest and most efficient way. In the TPS Toyota implemented the jidoka which means the process of the automation by the human touch. Thereby they are able eliminate the chance of production of defective products with the human touch. The whole TPS concept works based on stopping the machine when any problem or defective product is produced. With the adoption of TPS the machinery process becomes less time consuming and flawless and hence the maintenance also takes only less time. The main philosophy of the complete reduction of waste in the production of most effective production process. Reduction of the waste in TPS comprises of all the wastages like excess of inventories, extra processing steps and defective products and these small wastages conglomerate to a huge wastage which will affect the company. Thus, TPS was

introduced to yield profit to the company by the reduction of types of wastages that the company encounter during their processes.

(Amasaka,2002) the production of Toyota contributes the TPS in the 20th century to the world of production industries. The TPS was enhanced by the Toyota through the incorporation quality management principles and was coined the term JIT. The objectives are to build quality with the implementation by adhering to the principles of cost reduction. That's the reason why Toyota had taken the TPS and total quality management as the two pillars of their entire production management. The JIT concept and approach changed the vehicle production of Toyota. As a result of worldwide evaluations of the JIT effects, JIT turns out to be the main concept of manufacturing industries and the world in the 20th century. JIT renovates the business process of each division, which constitutes business rules, with the aim of treating customers choice first with incorporation of quality management. The implementation of JIT as the combination of TPS and Total quality management magnifies the excellence in all fields of their working like the sales, design, development and production and thus the implementation of JIT yields the company greater results in the working.

4.10 DATA ANALYSIS

(Durcevic,2019) Data analysis is the process of gathering, evaluating, inspection data to extract results that support the decision making. There are several methods and techniques which are widely used to get the data analysis done depending upon the objectives of the analysis. Some of the data analysis methods the correlation and regression are widely used in the business world to aid the decision making and prediction. (Ghatak,2020) Correlation is the type of data analysis method which is used for finding what is the nature of relation between two variables in a given dataset. Two variables are said to be related when the change in one variable constitute a change in the other variable. Correlation can take positive, negative values or zero correlation and it depends on the relationship between the variables. (Calvello,2020) states that the clear picture of a correlation can be better understood by the correlation chart or the scatter diagram as it shows how the correlation between the two variables are carried out. The correlation analysis gives the emergence of a constant called the Pearson's Correlation Coefficient, commonly known as the correlation coefficient R. the

value of R revolves around the values -1 to +1(R. Sudrez, 2015). (Durcevic,2019) Regression is used in the data analysis of prediction purpose to get done. Regression is a data analysis method which will help the organization to do a forecast about their activity in future. The regression will give the values of the dependent variable for a certain value of the independent variable which gives the value of the dependent variable for the coming independent variables in the future. Regression gives the possibility of finding the value of the dependent variable with the respective value of the independent variable with help of an equation (Calvello,2020).

The equation is y=b(x)+a

Where a represents the y intercept, b is the slope and y and x are the dependent and independent variables respectively (Calvello,2020).

YEAR	WORLD WIDE PRODUTION	PRODUCTION IN JAPAN	OVERSEAS PRODUCTION
1952	14,106	14,106	
1953	16,496	16,496	
1954	22,713	22,713	
1955	22,786	22,786	
1956	46,417	46,417	
1957	79,527	79,527	
1958	78,856	78,856	
1959	101,194	101,194	489
1960	154,770	154,770	459
1961	210,937	210,937	2,503
1962	230,350	230,350	2,029
1963	318,495	318,495	7,586
1964	425,764	425,764	10,824
1965	477,643	477,643	12,446
1966	587,539	587,539	23,391
1967	832,130	832,130	35,036
1968	1,097,405	1,097,405	63,934
1969	1,471,211	1,471,211	80,340
1970	1,609,190	1,609,190	75,575
1971	1,955,033	1,955,033	103,478
1972	2,087,133	2,087,133	102,234
1973	2,308,098	2,308,098	123,869
1974	2,114,980	2,114,980	138,371
1975	2,336,053	2,336,053	154,208
1976	2,487,851	2,487,851	160,715
1977	2,720,758	2,720,758	176,855

Figure 6: Data set used (Toyota annual report,2011)

The full data set is shown in the appendix

(Toyota annual report,2011) Data analysis is done on the data achieved from the Toyota production starting from the year 1950s as the inception of JIT had been started from this period onwards and afterwards the JIT had evolved so much. The data parameters which are used here for the data analysis are the year in which production are done and worldwide production in the respective years.

	YEAR	WORLD WIDE PRODUTION
YEAR	1	
WORLD WIDE PRODUTION	0.976499931	1

Figure 7: Correlation analysis (own calculation)

The correlation coefficient got after the analysis done in figure 6 is .976499931 which can be rounded as 0.976. (R. Sudrez, 2015) The correlation coefficient should be always between two values like +1 to -1 and here the value we got 0.976 and it greater than zero which states the give data set indicates a positive correlation between the two parameters. As the correlation coefficient falls in the range of +1 to -1 it denotes that the independent and dependent variables in the respective data sets have a very good relation between them. A earlier aid the linear regression is done for the prediction of the datasets in the future like to predict the coming values of the dependent variable on the basis of the change in the independent variable (Durcevic,2019).

Regression Statistics	
Multiple R	0.976499931
R Square	0.953552115
Adjusted R Square	0.952751289
Standard Error	534819.475
Observations	60

Figure 8: Regression statistics (own calculation)

(Vijalapuram,2019) In this analysis we got the R square value as 0.953552115 which can be rounded to the value 0.953 which states according to the analysis that values of the independent variable (which is the parameter years in data set) can explain 95 % of variation

of the dependent variable (which is the parameter worldwide production in the dataset). Mostly the R square value lies between the value the 1 and 0 and also the more increase in the R square value will explain more variation in the dataset and the much convenient the data set becomes for the prediction (Vijalapuram,2019).

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	3.40581E+14	3.40581E+14	1190.711313	2.34608E-40
Residual	58	1.65898E+13	2.86032E+11		
Total	59	3.57171E+14			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*ower 95.0%*	*pper 95.0%*
Intercept	-269342339.1	7900270.306	-34.09280046	4.57353E-40	-285156448.3	-2.5E+08	-2.9E+08	-2.5E+08
YEAR	137573.4181	3986.862775	34.50668505	2.34608E-40	129592.8452	145554	129592.8	145554

Figure 8: ANOVA table (own calculation)

(Vijalapuram,2019) The significance F value is nothing but the value of the p for the null hypothesis which mean the coefficient of the independent variable is zero. The lower p value always indicate there is a notable relationship between the dependent and independent variable. The significance F value should be always less than 0.05, in the calculation it is found to be 2.34^{-40} from figure 8, then we can say that there are enough proof to state that there exists significant relationship between the dependent and independent variables, here it is the Worldwide production and the years respectively. And also, the p value for dependent the variables are close to zero which also gives a firm proof that there exists significant relationship between the two variables in analysis.

(Vijalapuram,2019) Residuals table got from data analysis of the regression analysis is very important in the prediction process of the dataset and can be considered as a important section to noted. Residuals are the basically the difference between the actual and predicted values of the regression analysis. The predicted value of the dependent variable in the regression analysis can be very used for the prediction process prediction of the whole data in the coming future or can be used to say what trend will the dataset exhibit in the coming time. Residual table will show the predicted value of the dependent variable for each data point in the dataset. Here the predicted value of the dependent variable shows increase in most of the data points in data set. Therefore, we can say that the dependent variable will be in a

increasing manner in the coming future. Hence the production of the company will be increasing in the coming future which will give more profits. Hence the JIT implementation in the SC as a tool yields good profit for the company (Research gap addressed).

RESIDUAL OUTPUT		
Observation	*Predicted WORLD WIDEPRODUTION*	*Residuals*
1	-799026.9344	813132.9
2	-661453.5163	677949.5
3	-523880.0982	546593.1
4	-386306.6801	409092.7
5	-248733.262	295150.3
6	-111159.8438	190686.8
7	26413.57427	52442.43
8	163986.9924	-62793
9	301560.4105	-146790
10	439133.8286	-228197
11	576707.2467	-346357
12	714280.6649	-395786
13	851854.083	-426090
14	989427.5011	-511785
15	1127000.919	-539462
16	1264574.337	-432444
17	1402147.755	-304743
18	1539721.174	-68510.2
19	1677294.592	-68104.6
20	1814868.01	140165
21	1952441.428	134691.6
22	2090014.846	218083.2
23	2227588.264	-112608
24	2365161.682	-29108.7
25	2502735.1	-14884.1

Figure 9: Residual table (own calculation)

The full residual table will be shown in the appendix

4.11 ADVANCEMENTS OF SUPPLY CHAIN IN THE MODERN INDUSTRY

What are the advancements of supply chain in the modern industry?

During the growth of the world in all aspects it also has predominant advancements in the SC and its technologies used. These new advancements that they adopted to enhance the SC are very different on comparison with the conventional methods that they adopted earlier in the past time. (Blossey et al.,2019) states that among these advancements they adopted to implement in SC the block chain technology had given so many better results and easiness for them in SCM. BCT contains a single record of a data which is kept in the blocks of data. These blocks are stored in certain nodes which can considered like small servers. These nodes can be accessed by the participants in the block chain, and they are marked with the date and time on which it is accessed and altered and only can be accessed by going through a series of protocols of BCT network and encryption. Thus, is one of the main advancements recently come in the world which is more secure and eliminates the need for a trusted entity and costly software for keeping the data in the SCM safe. Since these nodes are always present in the block chain always the accessibility of these data can be done from anywhere and make processing of these data easier unless the concerned person who does the process is member of the block chain. BCT provide four features that can integrate and coordinate the members of the SC. (Blossey et al.,2019) The features are:

- Transparency: states the accessibility of data collected from different sources and members of the SC to the members of the respective block chain.
- Validation: refers to the unchangeability of the data and the verification for the authentication of data is carried out in the validation.
- Automation: represents to the chance of creation of small contracts based on verified information from the block chain.
- Tokenization: tokenization states the creation of small tokens which used for claiming on any precious assets and exchange of these assets between the block chain members.

(Di Vaio and Varriale ,2019) says that the use of BCT had triggered the coordination of all the elements in the SC in a well manner, like from the supplier to the retailers. The BCT gives an output with the high level of integration with the help of its data accessibility with all the members in the block chain and the high safety of the data in the BCT. Thus, BCT delivers better advantages which can't be provided by the traditional logistics systems. By the high security of data in BCT the SC had transformed into more trustworthy method for integration within their member of the SC. (Cole et al. ,2019) BCT had benefited the SCM in many ways, these benefits are well values for the SC. The main benefits that are very simply carried out with the BCT on comparison with the older techniques are the easiness in tracing of the products from the source to the consumer, product recalls etc. Mapping of the complex SC becomes more easier with implementation of the BCT and can be understood and accessed very easily also. With implementation of the BCT the complex SC are now having a very good and easy step for the storing of the whole data in a much cost-effective way.

CHAPTER 5: CONCLUSION

This research deals with the working of the SCM in the production industries and the challenges that they face in the implementation. The strategies that the production companies adopted as a remedial measure for the challenges that they face are like the maintaining of better SRM, lean supply chain management, JIT and the modern technology of adoption of BCT in the SCM. The SRM help the production companies to maintain a close relation or make the relation thicker by the more integration of the suppliers in the decision making and the giving sufficient knowledge about the processes carried out in SC. The main challenge that the company are facing in the SCM is the extravagance of inventory, time and money which may bring the whole company in deep loss. As a strategy to counter these challenges the SC starts the adoption LSCM to limit the wastage in SC process, improve the quality and relationship, better value chain analysis. The LSCM also have some special tools like the JIT which is very helpful in elimination of the inventory expenses and the time-to-time delivery of the products when it is needed to get process, therefore the lead time in the production get reduced very much. In this research the scope of JIT in the coming future of the production industries is proved by the data analytics methods. For the data analysis the data of Toyota

company production in all over the world is taken. In data analysis the data from 1950 are taken as this time marks the start of JIT technology in Toyota. Along with the growing world of technology the SC had started the use of the BCT in their SCM. BCT aids the SCM very much in the storage of the data and eliminate the use costly methods of storing data like buying high end software and encryptions for the safe keeping. With high security of BCT helps the SCM to become more authentic with data collection and process.

5.1 LIMITATIONS

The dissertation goes by the collection and use of secondary data. So, if any flaw that are present in the collected data may also reflect some errors in the data processing part in this dissertation. The strategies which are proposed like the LSCM, JIT, BCT have its own limitation. How well these strategies help the SCM to be in stable condition to promote profit in the industries, but it becomes futile when some unprecedented issues happen. (Jaeger,2021) The recent unprecedented issue that had created a wide impact on SC adversely is the blockage at Suez Canal by a big cargo ship of 1300 foot high which disrupts the supply chain and causes heavy loss for companies and created a ripple impact which lasts for coming times as well. At this stage the strategies like JIT and LSCM also suffered quite well in the functioning due to the shortage of supplies. And even this adverse situation BCT can be used by SCM team to track the goods in the transition state and can account for the delays that these goods may face but still due to the less interference of the BCT in all companies or suppliers link in a SCM it can't widely adopted to all the parties who got problem in this blockage of supplies in the Suez Canal.

5.2 RECOMMEDATIONS

As the world of technology is progressing all days in every field the SC have significant implementation of new technologies like the BCT. The BCT is very secured and intelligent platform which facilitates data storage and processing. Through BCT the SC managers or the members are very clear about traceability, quality and can cross heck the data at any time with the proper protocols and access from the concerned authority. This BCT is but now used only by some big companies and it is still unknown thing for other companies in the global SC. The implementation and the proper awareness of the new modern technologies should be

done by all the companies who takes a part in the SC. Thus, will be able to make the data process, storage and processing for other functions SCM in amore secured and systematic manner.

REFERENCES

Kenton, W. (2020). *Supply Chain*. [online] Investopedia. Available at: https://www.investopedia.com/terms/s/supplychain.asp.

Slack, N., Chambers, S. and Johnston, R. (2007). *Operations management (5a. ed.)*. Distrito Federal: Pearson Educación.

Sunil Chopra (2013). *Supply chain management : strategy, planning, and operation*. Boston: Pearson.

Daneshvar, M., Razavi Hajiagha, S.H., Tupėnaitė, L. and Khoshkheslat, F. (2020). Effective factors of implementing efficient supply chain strategy on supply chain performance. *Technological and Economic Development of Economy*, 26(4), pp.947–969.

Williams, M. and Ludwig, C. (2021). *Why just-in-time will remain the way forward for Toyota*. [online] Automotive Logistics. Available at: https://www.automotivelogistics.media/oems/why-just-in-time-will-remain-the-way-forward-for-toyota/41826.article.

R.Nicole. (2010). *The Origins of Just-In-Time ⋆ Quality and Innovation*. [online] Available at: https://qualityandinnovation.com/2010/10/13/the-origins-of-just-in-time/.

Krajewski, L.J., Malhotra, M.K. and Ritzman, L.P. (2016). *Operations management. Processes and supply chains*. Boston: Pearson.
George, J. and Pillai, V.M. (2019). A study of factors affecting supply chain performance. *Journal of Physics: Conference Series*, 1355, p.012018.

McAllister, G. 2021. Major Issues Facing Supply Chain Managers. *Spend Culture*. Available at: https://blog.procurify.com/2021/03/02/4-major-issues-facing-your-supply-chain-manager/.

Pettey, C. (2018) *Gartner top 8 supply chain technology trends for 2018*, *Gartner.com*. Available at: https://www.gartner.com/smarterwithgartner/gartner-top-8-supply-chain-technology-trends-for-2018/ .

Gaur, V. and Gaiha, A. (2020). *Building a Transparent Supply Chain*. [online] Harvard Business Review. Available at: https://hbr.org/2020/05/building-a-transparent-supply-chain .

Bendis, M. (2021) *2021 Supply Chain and Inventory Management Trends*, *Eazystock.com*. Available at: https://www.eazystock.com/blog/2021-supply-chain-inventory-management-trends/ .

Rector, E. (2019) *Supplier diversification*, *Marketscale.com*. Available at: https://marketscale.com/industries/aec/articles-aec/supplier-diversification/ .

Murray, M. (2020) *What is a just-in-time supply chain?*, *Thebalancesmb.com*. Available at: https://www.thebalancesmb.com/just-in-time-jit-2221262

Mishra, O.P., Kumar, V. and Garg, D. (2013). JIT supply chain; an investigation through general system theory. *Management Science Letters*, 3(3), pp.743–752.

Murray, M. (2019) *Lean supply chain management*, *Thebalancesmb.com*. Available at: https://www.thebalancesmb.com/lean-supply-chain-management-2221274.

Briefing, C. (2016). *Changing Course: e-Commerce and its Impact on the Automotive Aftermarket*. [online] China Briefing News. Available at: https://www.china-briefing.com/news/changing-course-ecommerce-and-its-impact-on-the-automotive-aftermarket/ .

Different Types of Data for your Dissertation | 15 Writers. [online] Available at: https://15writers.com/complete-guide-dissertation-data/.

Moura, P.D.F.T. (2018). *What to Include in the METHODOLOGY Chapter of Your Thesis*. [online] LiveInnovation.org. Available at: https://liveinnovation.org/what-to-include-in-the-methodology-chapter-of-your-thesis/.

skillsyouneed.com 2011- (2011) *Writing your dissertation: Methodology*, *Skillsyouneed.com*. Available at: https://www.skillsyouneed.com/learn/dissertation-methodology.html.

Bradford, A. and published, M.W. (2021). *Deductive Reasoning vs. Inductive Reasoning*. [online] livescience.com. Available at: https://www.livescience.com/21569-deduction-vs-induction.html#section-what-is-inductive-reasoning.

Paul b Zimmerman. (2019). *Supply chain management for the manufacturing industry*. Pbzmfg.Com. https://www.pbzmfg.com/blog/supply-chain-management-for-the-manufacturing-industry/

Alnasser, A. (2013). Honda Supply Chain. *International Journal of Scientific & Engineering Research*, [online] 4. Available at: https://www.ijser.org/researchpaper/Honda-Supply-Chain.pdf.

Ab Rahman, M.N, Ismail ,A.R,Dero, M.d and Rosil , M.E (2008). Barriers to SCM implementing. *Journal of achievements in Materials and Manufacturing Engineering*, 31(2).

Bala, K. (2014).Supply chain management : Issues and Challenges – A review. *International Journal of Current Engineering and Technology* , 4(2).

Daniel, D., & Pratt, M. K. (2020). *What is Supplier Relationship Management (SRM)?* SearchERP; TechTarget. Available at:https://searcherp.techtarget.com/definition/supplier-relationship-management-SRM

Al-Abdallah, G.M., Abdallah, A.B. and Bany Hamdan, K. (2014). The Impact of Supplier Relationship Management on Competitive Performance of Manufacturing Firms. *International Journal of Business and Management*, 9(2).

MacDuffie, J.P. and Helper, S. (1997). Creating Lean Suppliers: Diffusing Lean Production through the Supply Chain. *California Management Review*, 39(4), pp.118–151.

Singh, D. and Verma, A. (2018). Inventory Management in Supply Chain. *Materials Today: Proceedings*, [online] 5(2), pp.3867–3872.

Stanton, D. (2018). *cost drivers in supply chain management*. [online] Dummies.com. Available at: https://www.dummies.com/article/business-careers-money/business/operations/cost-drivers-supply-chain-management-249035.

Garcia-Buendia, N., Moyano-Fuentes, J. and Maqueira-Marín, J.M. (2021). Lean supply chain management and performance relationships: what has been done and what is left to do. *CIRP Journal of Manufacturing Science and Technology*, 32, pp.405–423.

Ugochukwu, P., Engstr¨om, J., & Langstrand, J. (2012). LEAN IN THE SUPPLY CHAIN: A LITERATURE REVIEW. *Management and Production Engineering Review*, *3*(4), 87–96.

Martínez-Jurado, P. J., & Moyano-Fuentes, J. (2014). Lean Management, Supply Chain Management and Sustainability: A Literature Review. *Journal of Cleaner Production*, *85*, 134–150. https://doi.org/10.1016/j.jclepro.2013.09.042

Wee, H.M. and Wu, S. (2009). Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company. *Supply Chain Management: An International Journal*, 14(5), pp.335–341.

Del Vecchio, L. (2019). *what is just in Time-Inventory Management*. Planergy.com. Available at: https://planergy.com/blog/jit-just-in-time-inventory-management/

Mishra, O.P., Kumar, V. and Garg, D. (2013). JIT supply chain; an investigation through general system theory. *Management Science Letters*, 3(3), pp.743–752.

Shrimpton, D. (2018). *Can "Just in Time" #JIT work in Software Development*. [online] Medium. Available at: https://medium.com/@davidshrimptonds/can-just-in-time-jit-ever-work-in-software-development-185de89fdaa1.

Toyota (2019). *Toyota production system*. [online] Toyota Motor Corporation Official Global Website. Available at: https://global.toyota/en/company/vision-and-philosophy/production-system/.

Amasaka, K. (2002). "New JIT": A new management technology principle at Toyota. *International Journal of Production Economics*, 80(2), pp.135–144.

Durcevic, S. (2019). *Learn Here Different Ways Of Data Analysis Methods & Techniques*. [online] BI Blog | Data Visualization & Analytics Blog | datapine. Available at: https://www.datapine.com/blog/data-analysis-methods-and-techniques/.

Ghatak, D. (2020). *Data Science : Correlation vs Regression in Statstics*. [online] Knowledgehut.com. Available at: https://www.knowledgehut.com/blog/data-science/correlation-vs-regression.

Calvello, M. (2020). *Correlation vs. Regression Made Easy ;Which to use + Why*. [online] g2.com. Available at: https://www.g2.com/articles/correlation-vas-regression#:~:text=Correlation.

R.Sudrez, H. (2015). *What is a correlation? And data analysis tools.* [online] incibe-cert.es. Available at: https://www.incibe-cert.es/en/blog/correlation-and-data-analysis-tools.

Toyota-global.com. (2011). *TOYOTA MOTOR CORPORATION GLOBAL WEBSITE | 75 Years of TOYOTA | Production | Production Overview*. [online] Available at: https://www.toyota-global.com/company/history_of_toyota/75years/data/automotive_business/production/production/overview/index.html.

Vijalapuram, S. (2019). *How to read a Regression Table*. [online]freecodecamp.org. Available at: https://www.freecodecamp.org/news/https-medium-com-sharadvm-how-to-read-a-regression-table-661d391e9bd7-708e75efc560/

Blossey, G., Eisenhardt, J. and Hahn, G. (2019). *Blockchain Technology in Supply Chain Management: An Application Perspective*. [online] scholarspace.manoa.hawaii.edu. Available at: https://scholarspace.manoa.hawaii.edu/handle/10125/60124

Di Vaio, A. and Varriale, L. (2019). Blockchain technology in supply chain management for sustainable performance: Evidence from the airport industry. *International Journal of Information Management*.

Cole, R., Stevenson, M. and Aitken, J. (2019). Blockchain technology: implications for operations and supply chain management. *Supply Chain Management: An International Journal*, 24(4), pp.469–483.

Jaeger, Jaclyn. (2021)"Bracing for Impact: Supply Chain Risk Management Post-Suez Canal Blockage." *Compliance Week* [online], Available at: https://www.complianceweek.com/supply-chain/bracing-for-impact-supply-chain-risk management-post-suez-canal-blockage/30298.article

APPENDIX

year	Worldwide production	Production in Japan	Overseas production
1935	20	20	
1936	1,142	1,142	
1937	4,013	4,013	
1938	4,615	4,615	
1939	11,981	11,981	
1940	14,787	14,787	
1941	14,611	14,611	
1942	16,302	16,302	
1943	9,827	9,827	
1944	12,720	12,720	
1945	3,275	3,275	
1946	5,821	5,821	
1947	3,922	3,922	
1948	6,703	6,703	
1949	10,824	10,824	
1950	11,706	11,706	
1951	14,228	14,228	
1952	14,106	14,106	
1953	16,496	16,496	
1954	22,713	22,713	
1955	22,786	22,786	
1956	46,417	46,417	
1957	79,527	79,527	
1958	78,856	78,856	
1959	101,194	101,194	489

A19 1952

	A	B	C	D	E
25	1958	78,856	78,856		
26	1959	101,194	101,194	489	
27	1960	154,770	154,770	459	
28	1961	210,937	210,937	2,503	
29	1962	230,350	230,350	2,029	
30	1963	318,495	318,495	7,586	
31	1964	425,764	425,764	10,824	
32	1965	477,643	477,643	12,446	
33	1966	587,539	587,539	23,391	
34	1967	832,130	832,130	35,036	
35	1968	1,097,405	1,097,405	63,934	
36	1969	1,471,211	1,471,211	80,340	
37	1970	1,609,190	1,609,190	75,575	
38	1971	1,955,033	1,955,033	103,478	
39	1972	2,087,133	2,087,133	102,234	
40	1973	2,308,098	2,308,098	123,869	
41	1974	2,114,980	2,114,980	138,371	
42	1975	2,336,053	2,336,053	154,208	
43	1976	2,487,851	2,487,851	160,715	
44	1977	2,720,758	2,720,758	176,855	
45	1978	2,929,157	2,929,157	199,991	
46	1979	3,074,832	2,996,225	78,607	
47	1980	3,377,582	3,293,344	84,238	
48	1981	3,327,300	3,220,418	106,882	
49	1982	3,283,372	3,144,557	138,815	
50	1983	3,406,431	3,272,335	134,096	
51	1984	3,583,320	3,429,249	154,071	

1985	3,801,929	3,665,622	136,307
1986	3,812,691	3,660,167	152,524
1987	3,830,539	3,638,279	192,260
1988	4,213,068	3,968,697	244,371
1989	4,447,483	3,975,902	471,581
1990	4,890,028	4,212,373	677,655
1991	4,754,998	4,085,081	669,917
1992	4,695,807	3,931,341	764,466
1993	4,450,464	3,561,750	888,714
1994	4,559,748	3,508,456	1,051,292
1995	4,424,701	3,171,277	1,253,424
1996	4,756,093	3,410,060	1,346,033
1997	4,892,117	3,502,046	1,390,071
1998	4,634,076	3,165,805	1,468,271
1999	4,729,266	3,118,226	1,611,040
2000	5,180,651	3,429,209	1,751,442
2001	5,135,027	3,354,424	1,780,603
2002	5,640,383	3,485,162	2,155,221
2003	6,078,296	3,520,317	2,557,979
2004	6,723,674	3,680,946	3,042,728
2005	7,360,742	3,789,582	3,571,160
2006	8,093,163	4,194,188	3,898,975
2007	8,534,690	4,226,137	4,308,553
2008	8,210,818	4,012,388	4,198,430
2009	6,371,291	2,792,274	3,579,017
2010	7,623,349	3,282,855	4,340,494
2011	6,928,813	2,760,028	4,168,785

The whole data set is shown here and is taken form https://www.toyota-global.com/company/history_of_toyota/75years/data/automotive_business/production/production/overview/index.html

RESIDUAL OUTPUT		
Observation	*Predicted WORLD WIDEPRODUTION*	*Residuals*
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6	-111159.8438	190686.8
7	26413.57427	52442.43
8	163986.9924	-62793
9	301560.4105	-146790
10	439133.8286	-228197
11	576707.2467	-346357
12	714280.6649	-395786
13	851854.083	-426090
14	989427.5011	-511785
15	1127000.919	-539462
16	1264574.337	-432444
17	1402147.755	-304743
18	1539721.174	-68510.2
19	1677294.592	-68104.6
20	1814868.01	140165
21	1952441.428	134691.6
22	2090014.846	218083.2
23	2227588.264	-112608
24	2365161.682	-29108.7
25	2502735.1	-14884.1

	A	B	C	D	E
36		4016042.7	-185504		
37		4153616.118	59451.88		
38		4291189.536	156293.5		
39		4428762.954	461265		
40		4566336.372	188661.6		
41		4703909.79	-8102.79		
42		4841483.208	-391019		
43		4979056.626	-419309		
44		5116630.045	-691929		
45		5254203.463	-498110		
46		5391776.881	-499660		
47		5529350.299	-895274		
48		5666923.717	-937658		
49		5804497.135	-623846		
50		5942070.553	-807044		
51		6079643.971	-439261		
52		6217217.389	-138921		
53		6354790.808	368883.2		
54		6492364.226	868377.8		
55		6629937.644	1463225		
56		6767511.062	1767179		
57		6905084.48	1305734		
58		7042657.898	-671367		
59		7180231.316	443117.7		
60		7317804.734	-388992		

24	2365161.682	-29108.7
25	2502735.1	-14884.1
26	2640308.518	80449.48
27	2777881.937	151275.1
28	2915455.355	159376.6
29	3053028.773	324553.2
30	3190602.191	136697.8
31	3328175.609	-44803.6
32	3465749.027	-59318
33	3603322.445	-20002.4
34	3740895.863	61033.14
35	3878469.282	-65778.3
36	4016042.7	-185504
37	4153616.118	59451.88
38	4291189.536	156293.5
39	4428762.954	461265
40	4566336.372	188661.6
41	4703909.79	-8102.79
42	4841483.208	-391019
43	4979056.626	-419309
44	5116630.045	-691929
45	5254203.463	-498110
46	5391776.881	-499660
47	5529350.299	-895274
48	5666923.717	-937658
49	5804497.135	-623846
50	5942070.553	-807044
51	6079643.971	-439261
52	6217217.389	-138921

The full residual table for the data analytics in the result and section is shown here.